
Test Procedure for

ESTIMATING CONCRETE STRENGTH BY THE MATURITY METHOD



TxDOT Designation: Tex-426-A

Effective Date: February 2010

1. SCOPE

- 1.1 This test method provides a procedure for estimating concrete strength by means of the maturity method. The maturity method is based on strength gain as a function of temperature and time.
 - 1.2 The maturity method consists of three steps:
 - developing strength-maturity relationship
 - estimating in-place strength
 - verifying strength-maturity relationship.
 - 1.3 This test procedure employs the Nurse-Saul temperature-time factor (TTF) maturity index, with a datum temperature of -10°C (14°F).
 - 1.4 The values given in parentheses (if provided) are not standard and may not be exact mathematical conversions. Use each system of units separately. Combining values from the two systems may result in nonconformance with the standard.
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2. APPARATUS

- 2.1 *Commercial battery-powered maturity meters*, automatically compute and display the maturity index in terms of a temperature-time factor or both a temperature-time factor and equivalent age.
 - 2.1.1 If the maturity meter has input capability for datum temperature, be sure to select the proper value of the datum temperature prior to each use.
 - 2.1.2 Use the same brand and type of maturity meters in the field as those used to develop and verify the strength-maturity relationship.
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3. PROCEDURE

- 3.1 *Calibration*—Verify calibration prior to use on a project and, as a minimum, on an annual basis by placing a randomly sampled maturity meter in a controlled-temperature water
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bath and recording whether the indicated result agrees with the known temperature of the water bath. The maturity meter temperature recording device must be accurate to within $\pm 1^{\circ}\text{C}$ ($\pm 2^{\circ}\text{F}$). Verify accuracy at a minimum of three different temperatures, e.g., 5°C , 25°C , and 45°C (41°F , 77°F , and 113°F).

3.2 *Developing Strength-Maturity Relationship:*

- 3.2.1 For every concrete design being evaluated by the maturity method, prepare a minimum of twenty cylinders or beams in accordance with Tex-447-A. The minimum size of each batch should be approximately 3 m^3 (4 yd.^3), using the same mixture proportions and constituents of the concrete as those of the job concrete being evaluated.

Note 1—Cast additional specimens to avoid having to repeat the procedure.

- 3.2.2 Test each batch of fresh concrete for concrete placement temperature, slump, and air content in accordance with Tex-415-A and either Tex-414-A or Tex-416-A.

- 3.2.3 Embed maturity meters in at least two specimens. Place the meter 50–100 mm (2–4 in.) from any surface. Begin data collection as soon as the meter contacts the fresh concrete. Data collection must be uninterrupted.

- 3.2.4 Moist-cure the specimens in a water bath or in a moist room in accordance with Tex-447-A.

- 3.2.5 Perform compression or flexural tests at 1, 3, 5, 7, 14, and 28 days in accordance with Tex-418-A or Tex-448-A, as appropriate. Test three specimens at each age and compute the average strength. Evaluate additional test specimens and test ages at the discretion of the Engineer.

Note 2— If a specimen is obviously defective (e.g., out of round, not square, damaged due to handling), discard the specimen. If an individual cylinder strength is greater than 10 percent (15 percent for beams) outside the average of three specimens, consider the specimen defective and discard. When two of the three specimens are defective, evaluate a new batch, unless additional acceptable specimens are available.

Note 3— Test the specimens with the meters last and only if the maximum dimension of the embedded meter is less than one-third the diameter of cylinder mold or width of the beam mold.

- 3.2.6 At each test age, record the individual and average values of maturity and strength for each batch on a permanent data sheet.

Note 4—Contact the Rigid Pavement and Concrete Materials Branch of the Construction Division's Materials and Pavements Section (CST/M&P) at (512) 506-5856 for a sample record log and maturity curve calculation program.

- 3.2.7 Plot the average strengths as a function of the average maturity values, with data points shown. Using a computer spreadsheet program such as Microsoft Excel, calculate a logarithmic best-fit curve through the data. Record the equation of the curve and the R^2 value. The resulting curve is the strength-maturity relationship to be used for estimating the strength of the concrete mixture placed in the field.

Note 5—When developing the strength-maturity relationship, the spreadsheet software allows the Engineer to develop the corresponding maturity equation that defines the

strength-maturity relationship and an R2 value to fit the strength-maturity relationship. The R2 value indicates the reliability of the strength-maturity relationship. Expected results should produce an R2 value of at least 0.90. When the reliability is less than 0.90, the Engineer should carefully examine the data for “outliers,” faulty beam breaks, or faulty maturity readings. The Engineer should use judgment to determine if certain points should be discarded, or retested, or whether the entire strength-maturity relationship should be regenerated.

- 3.2.8 The plot of the strength-maturity relationship for each concrete mixture, with data points, must be circulated and signed by the Contractor or his representative and reviewed by the District Materials Engineer or CST/M&P.

3.3 *Estimating In-Place Strength:*

- 3.3.1 A Department inspector must be present at the concrete plant when placing concrete to be evaluated by the maturity method. For Structural and Pavement Concrete, the inspector must be at the plant on a daily basis and must verify batching operations using a checklist. For Miscellaneous Concrete, the inspector must be at the plant a minimum of once per week on a random basis and must verify batching operations using a checklist. (See [Form 2174](#), “Inspector’s Batch Plant Checklist,” for example checklist.)

Note 6—Any alteration in mix proportions or source or type of any material, in excess of those tolerable by batching variability, requires the development of a new strength-maturity relationship prior to its use. This includes a change in type, source, or proportion of cement, fly ash, coarse aggregate, fine aggregate, or admixtures. A change in water-to-cementitious material ratio greater than 0.05 requires the development of a new strength-maturity relationship.

- 3.3.2 Prior to or at the time of concrete placement, install maturity meters at the frequency specified in the pertinent item of work. Install a minimum of two meters at locations in the structure that are critical in terms of structural considerations or exposure conditions as directed by the Engineer. Place meters 50–100 mm (2–4 in.) from any formed surface or at mid-depth of the section for sections less than 50 mm (4 in.).

Note 7—Meters may be tied to reinforcing steel but should not be in direct contact with the reinforcing steel or formwork.

- 3.3.3 When verification tests are required or when maturity will be used to estimate strength for removal of structurally critical formwork or falsework, or for steel stressing or other safety-related operations, perform specimen strength tests in accordance with Section 3.4.

- 3.3.4 As soon as practical after concrete placement, connect and activate the maturity meter(s).

Note 8—Do not disable meters until the required maturity values are achieved. Data collection must be uninterrupted.

- 3.3.5 Record maturity data on a permanent data sheet. The permanent data sheet must show the Required Strength and the Required TTF for the specified Operation.

Note 9—Contact the Rigid Pavement and Concrete Materials Branch of CST/M&P at (512) 506-5856 for a sample record log and maturity curve calculation program.

- 3.3.6 When the maturity is at a value that is equal to or greater than the required strength for that concrete mixture, as determined by the strength-maturity relationship, record the maturity value, and when appropriate per Section 3.3.3, verify the specimen strength in accordance with Section 3.4.
- 3.3.7 Clip the wires at the concrete surface.
- 3.4 *Verifying Strength-Maturity Relationship:*
- Note 10**—When maturity is used to estimate strength for removal of structurally-critical formwork or falsework, or for steel stressing or other safety-critical operations, the specimen strength tests may be included as Verification Tests.
- 3.4.1 Make a minimum of either three cylinders or three beams in accordance with Tex-418-A or Tex-448-A, respectively, at the frequency specified in the pertinent item of work.
- 3.4.2 Test fresh concrete for concrete placement temperature, slump, and air content in accordance with Tex-415-A and either Tex-414-A or Tex-416-A.
- 3.4.3 Embed one meter in a minimum of one specimen. Place meter(s) 50–100 mm (2–4 in.) from any surface. Begin data collection as soon as the meter contacts the fresh concrete. Data collection must be uninterrupted.
- 3.4.4 Moist-cure the specimens in a water bath or in a moist room in accordance with Tex-447-A.
- 3.4.5 Perform compression or flexural strength tests, as appropriate, when the specimen achieves the TTF (within 10%) corresponding to the design strength, or when the required TTF of the member is achieved in the field, if estimating strength for removal of structurally critical formwork or falsework or for steel stressing or other safety-related operations. Test the three specimens in accordance with Tex-418-A or Tex-448-A and computer the average strength of the specimens.
- Note 11**—If a specimen is obviously defective (e.g., out of round, not square, damaged due to handling), discard the specimen. If an individual cylinder strength is greater than 10 percent (15 percent for beams) outside the average of three specimens, consider the specimen defective and discard. When two of the three specimens are defective, evaluate a new batch, unless additional acceptable specimens are available.
- Note 12**—Test the specimen(s) with the meter last and only if the maximum dimension of the embedded meter is less than one-third the diameter of cylinder mold or width of the beam mold.
- 3.4.6 Compare the average strength determined from the specimen breaks to the strength predicted by the strength-maturity relationship. The average strength of the specimens must be within the verification tolerance specified for the item of work. When three consecutive verification test results fall between 5% and 10% above or below the predicted strength based on the S-M Relationship, the condition does not warrant a redo of the S-M Relationship; the condition, however, requires a mathematical adjustment to the S-M Relationship. Adjust the curve using the adjustment feature of the Excel spreadsheet program. When a single verification test exceeds the 10%, a new S-M Relationship curve must be developed according to specification requirements.

4. ARCHIVED VERSIONS

4.1 Archived versions are available.